

Three More Gymnotid Eels Found to Be Electrogenic

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(Plates I-III)

IT has been reported previously (Lissmann, 1951; Coates *et al.*, 1954; Coates, 1954) that three species of knifefishes, Family Gymnotidae, other than the well-known Electric Eel, *Electrophorus electricus*, are electrogenic. Three more species, never before regarded as electrogenic, are here reported as producing electric discharges more or less continually, and apparently in patterns peculiar to each species.

The three species are *Apteronotus albifrons*, of which two individuals were examined, *Steatogenes elegans* and *Sternarchus oxyrhynchus*. All three were found to emit electrical impulses of low amplitude and great regularity.

The discharges were measured by electrodes inserted into the fresh water in which the fishes were swimming freely, connected to a cathode ray oscillograph. The temperature of the water was 25° C. and the water was that to which the fishes were accustomed. The electrodes were insulated to their tips, which were silver, and were spaced at varying intervals as indicated in the figures. They were held as close to the test fish as possible without disturbing it, both when the fishes were swimming and when they were lying quietly at the bottom of the tank. Voltages measured in our experimental conditions did not exceed 400 millivolts.

A. albifrons was represented by two individuals, one of which was 215 mm. long and had been in captivity for more than two years. This specimen was presumed to be adult. The other was 50 mm. long and was obviously immature. Oscillographic traces of the discharges of these are shown in Plate I, Figs. 1 & 2. The regularity of the discharges of the adult is obvious, in contrast to the irregularity and lack of pattern of the other. There was no apparent difference between recordings made while the fish were either resting or swimming.

The pattern of discharge exhibited by *Steato-*

genes elegans, Plate I, Figs. 3 & 4, showed that it discharged regularly while resting (Fig. 3) and equally regularly, but about four times as fast when it was deliberately disturbed, (Fig. 4). This is an indication that the frequency of the discharges is centrally controlled.

Plate II shows the varying magnitude of the discharges of *A. albifrons* when the electrodes were placed near different parts of the body. This suggests that the organ producing the discharge is located in the caudal extremity, as might be expected in this family. The extreme regularity of the discharges is quite apparent in these figures.

The discharge of *Sternarchus oxyrhynchus*, Plate III, Figs. 11 & 12, shows the same regularity and almost the same frequency as that of *A. albifrons*, that is, about 1,000 discharges per second. Such high, steady rates of discharge are rarely encountered in any physiological systems.

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EXPLANATION OF THE PLATES

PLATE I

Oscillographic traces of discharge of *Apteronotus albifrons*. Time scale (lower line), 1,000 c. p. s.

FIG. 1. Adult fish.

FIG. 2. Immature fish.

Oscillographic traces of discharge of *Steatogenes elegans*. Time scale (lower line), 100 c. p. s.

FIG. 3. While resting.

FIG. 4. When disturbed.

PLATE II

Localization of discharge of *Apterionotus albifrons*. Time scale (lower line), 1,000 c. p. s.

FIG. 5. Drawing showing segments measured on oscillograph.

FIG. 6. With electrodes on "A" in drawing.

FIG. 7. With electrodes on "B" in drawing.

FIG. 8. With electrodes on "C" in drawing.

PLATE III

Oscillographic traces of discharge of three species, with electrodes 2.3 cm. apart.

FIG. 9. *Apterionotus albifrons*, slow sweep.

FIG. 10. *Apterionotus albifrons*, fast sweep.

FIG. 11. *Sternarchus oxyrhynchus*, slow sweep.

FIG. 12. *Sternarchus oxyrhynchus*, fast sweep.

FIG. 13. *Steatogenes elegans*, slow sweep.

FIG. 14. *Steatogenes elegans*, fast sweep.